Re-envisioning the Hydro Cycle

The Hydro Spiral as a Participatory Tool for Water Education and Management

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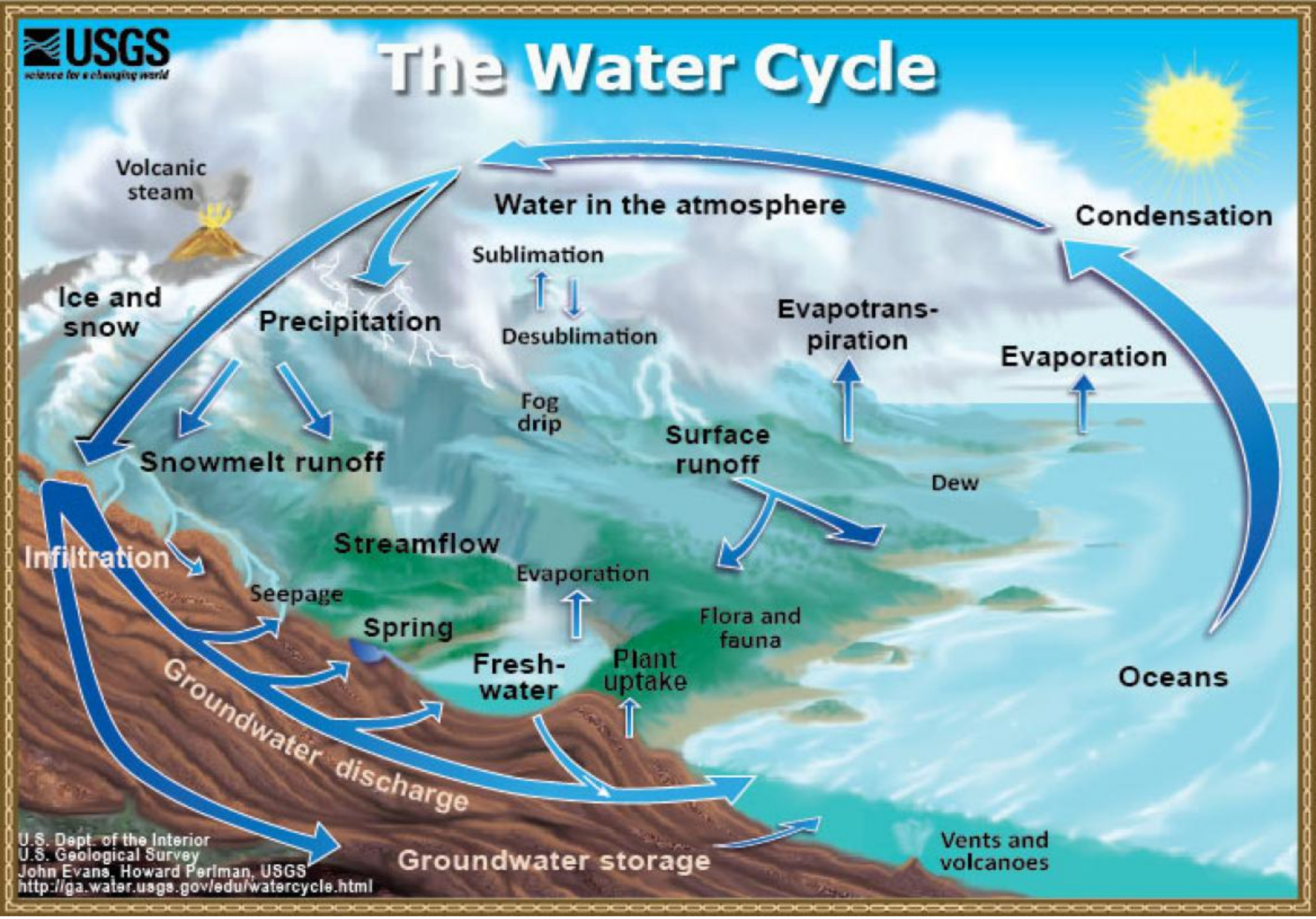
RGS-IBG Conference
2 September 2015

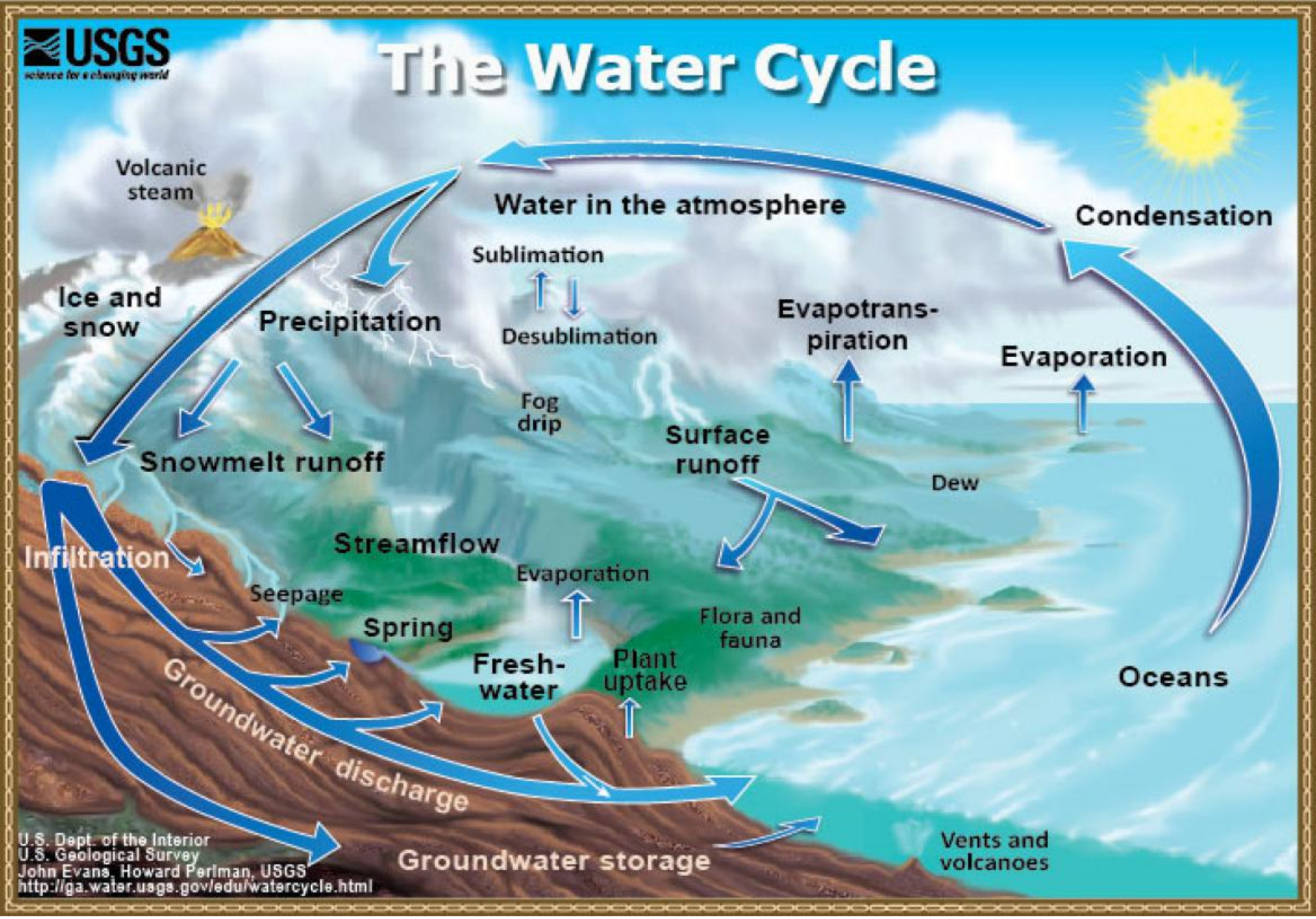
with Co-Author Charles D. Thompson and Co-Author & Artist Ruth Macdougall

Today:

- A History of the Hydro Cycle
- The Hydro Spiral Working Group
- Unveiling the Hydro Spiral
- The Spiral as a Participatory Tool

draw the hydro cycle


USGS
science for a changing world
The Water Cycle
Volcanic steam
Water in the atmosphere
Condensation
Sublimation
Desublimation
Ice and snow
Precipitation
Evapotrans-piration
Evaporation
Fog drip
Surface runoff
Snowmelt runoff
Dew
Infiltration
Streamflow
Evaporation
Seepage
Spring
Flora and fauna
Fresh-water
Plant uptake
Oceans
Groundwater discharge
Groundwater storage
Vents and volcanoes
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html



Do you see anything missing?

Figure 1. A depiction of the widely held notion of the subterranean source of springs and rivers, from Athanasius Kircher's *Mundus Subterraneus*, ca. 1664. The subterranean flow of water (originating at the sea bottom) is shown in darkened channels. The cutaway view illustrates the common belief that water was channelled to reservoirs beneath mountains from which it sprang forth, giving rise to springs and rivers.
Source: Adams (1938, 437)

From: Linton, Jamie (2008). "Is the Hydrologic Cycle Sustainable? A Historical-Geographical Critique of a Modern Concept." *Annals of the Association of American Geographers* 98(3): 630-649.

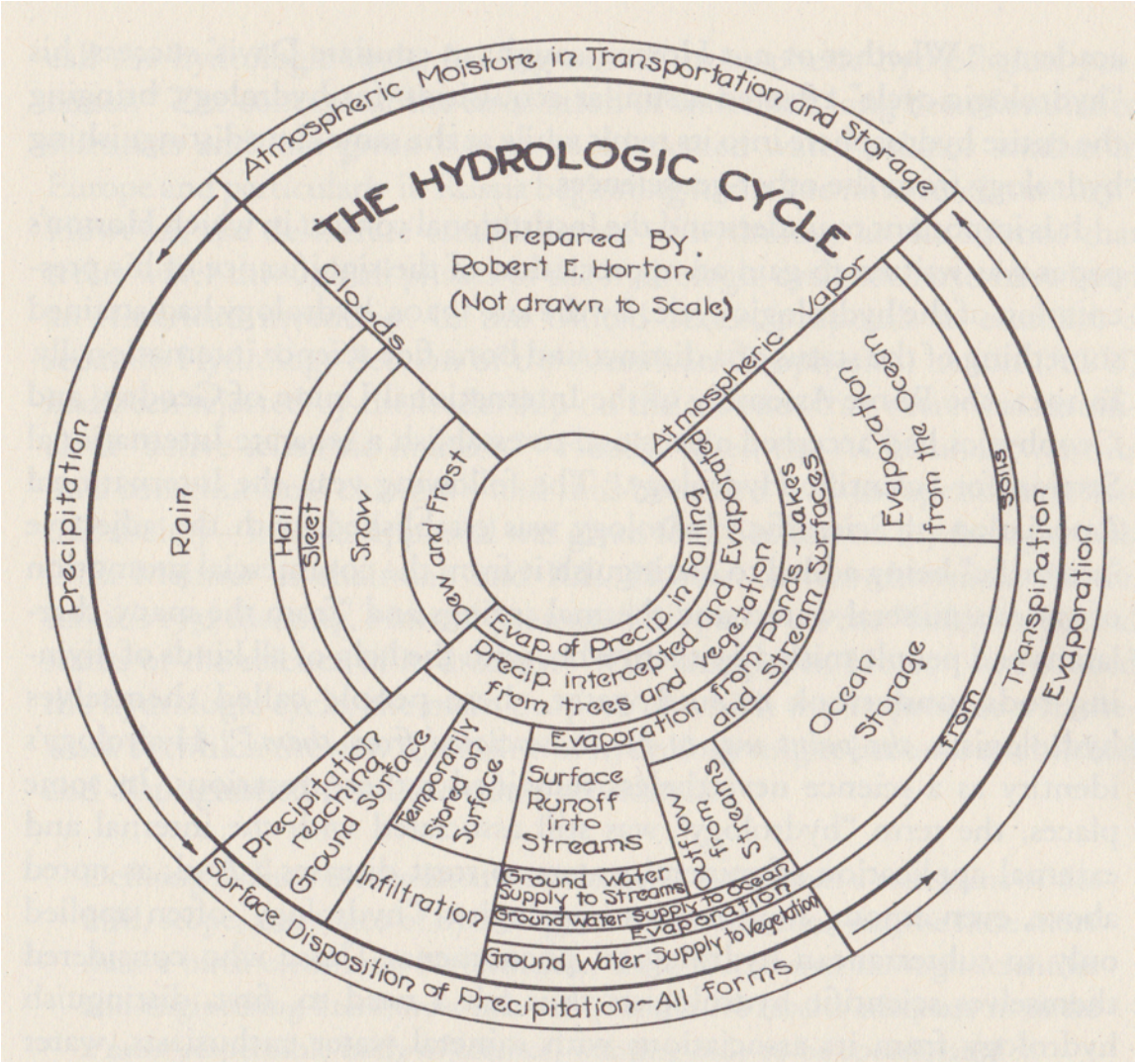
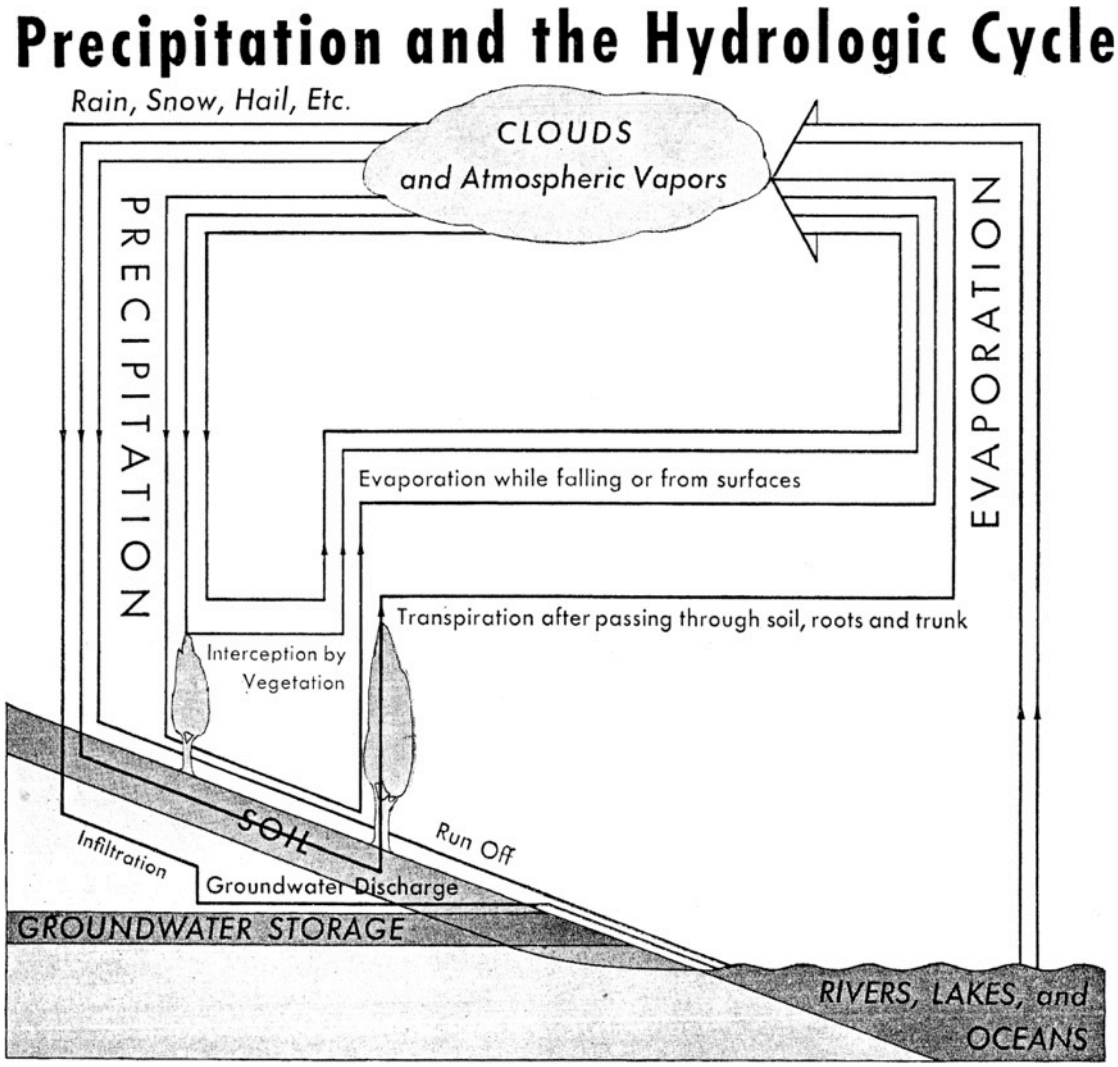


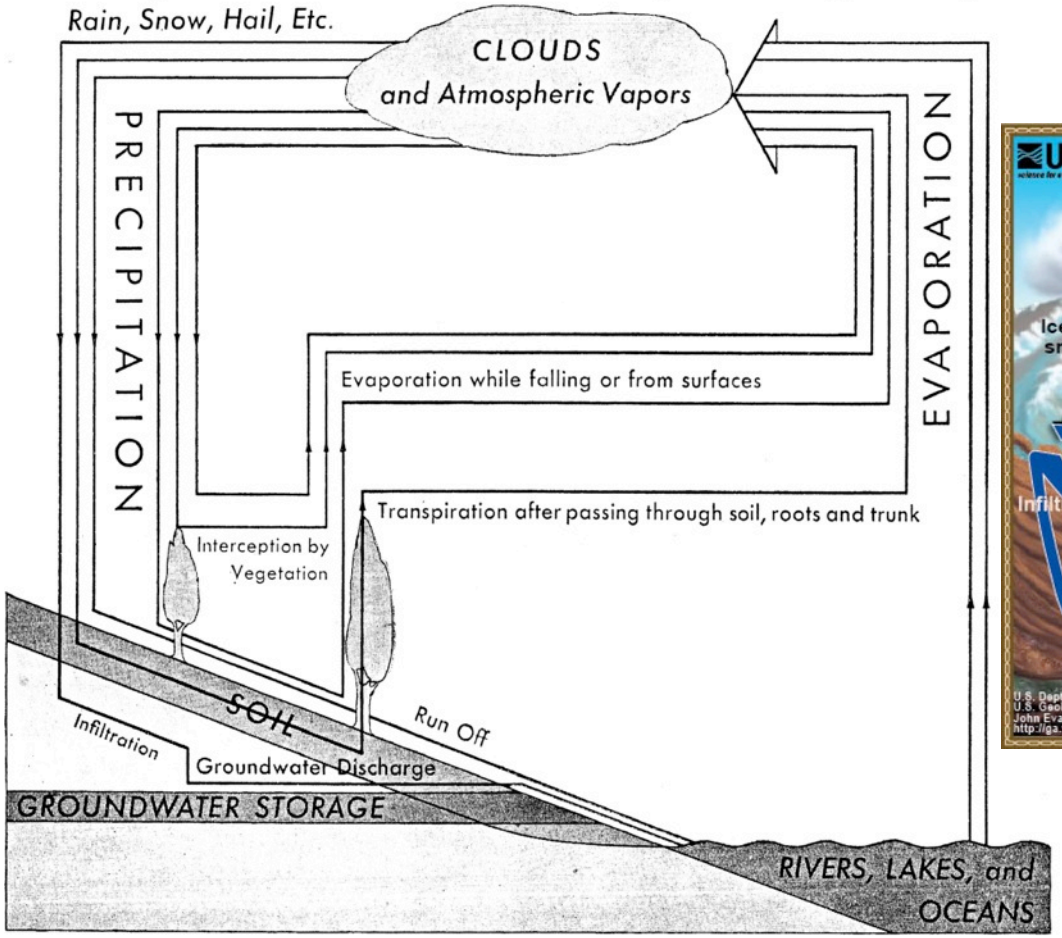
Figure 2. Horton's illustration of the hydrologic cycle. *Source:* Horton (1931, 193). Copyright © 1931 American Geophysical Union. Reproduced permission of the American Geophysical Union *in* Linton, Jamie (2008). "Is the Hydrologic Cycle Sustainable? A Historical-Geographical Critique of a Modern Concept." *Annals of the Association of American Geographers* 98(3): 630-649.



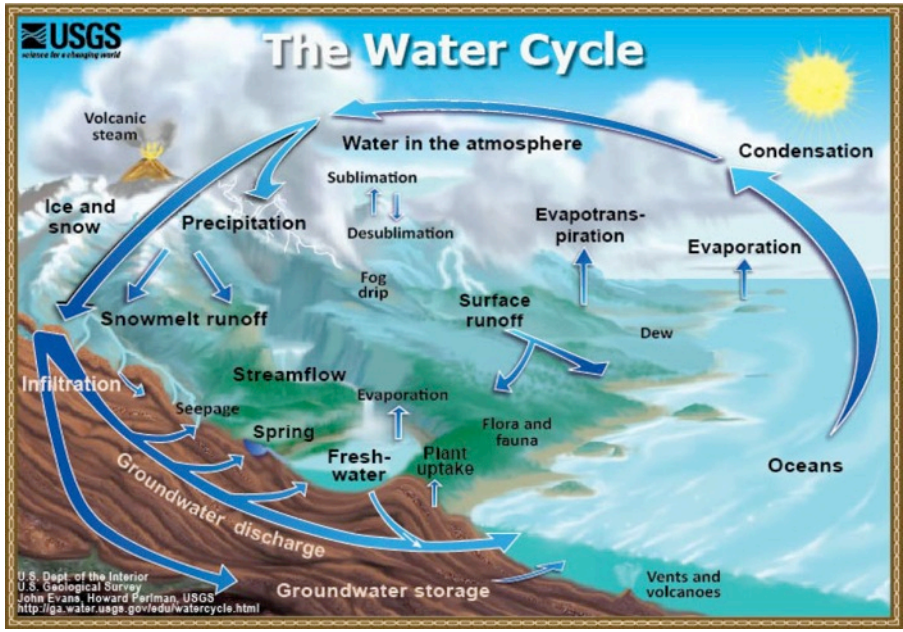
"Precipitation and the hydrologic cycle", National Resources Board, 1934: 262.

Source: Linton, Jamie (2008). "Is the Hydrologic Cycle Sustainable? A Historical-Geographical Critique of a Modern Concept." *Annals of the Association of American Geographers* 98(3): 638.

Precipitation and the Hydrologic Cycle



1934 Natural Resources Board



2013 USGS

What's Missing?

- Working group:
  - Interrogate this question
  - Create a new graphic?

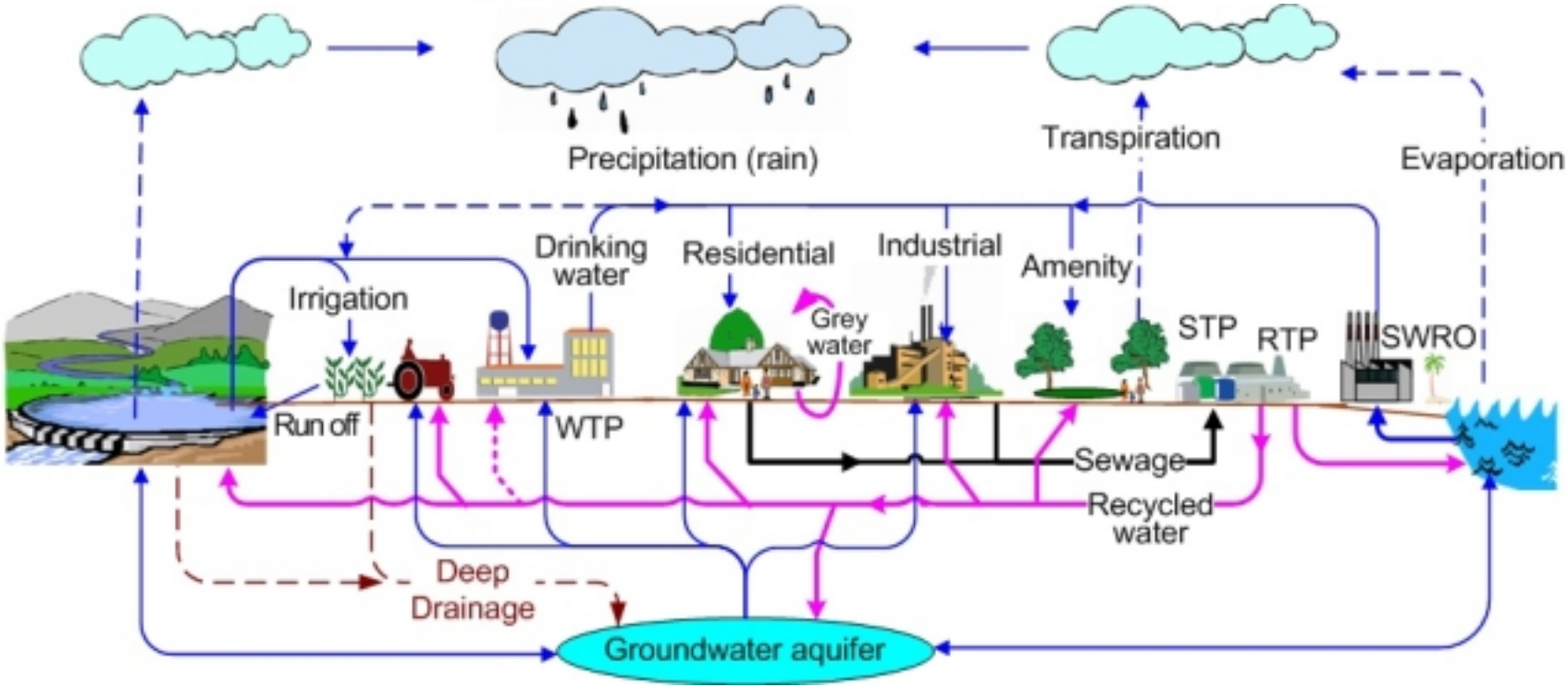
Issues to Incorporate *Geophysical Aspects*

- Advection
- Aquifer storage and recovery
- Climate change
- Condensation
- Deep percolation
- Erosion and Geological processes
  - Soil and rock drying, wetting, cracking, freezing, thawing, etc.
- Estuaries
- Evaporation
- Evapotranspiration
- Glaciers
- Groundwater
- Hydrofracking
- Hydroshearing
- Hyporheic zone and flows
  - Groundwater and surface water exchanges
- Infiltration
- Interception
- Macropores and flow
- Ocean storage
- Plant Uptake
- Precipitation
- River discharge
- Rivers, Lakes, Streams, Seas, Oceans
- Runoff
- Saltwater intrusion
- Snowmelt
- Soil moisture
- Springs
- Storage
  - Confined vs. unconfined
  - "Natural" vs. "Manmade" storage systems and management
- Sublimation
- Subsurface flows
  - Interflow, Throughflow, Groundwater flow
- Terrestrial and Aquatic ecosystems
  - Wetlands, Coral reefs, etc.
- Thermal stripping
- Transport
- Vapour, liquid, ice
- Water table

Issues to Incorporate *Political, Economic, Social, etc.*

- Aesthetics
- Agriculture
  - Blue vs. green crops
  - Irrigation Technologies
  - Rainfed
- Anthropogenic uses of water
- Biodiversity and environmental concerns
- Bioenergy
- Blue, green, grey, etc. – Colours of water
- Bottled water
- Cloud seeding
- Consumption patterns
- Consumptive vs. Non-consumptive uses
- Crops and livestock
- Dams
- Ecosystems goods and services
- Efficiency
  - Gains, losses, and the paracommons
- Fisheries, aquaculture
- GM Crops
- Industries
- Metaphysical and Spiritual Issues
  - Dowsing, Divining, Water witching
  - Baptism, cleansing, purification, etc.
- Outflow
- Political borders
- Pumping
- Quality
  - Pollution – acid rain, wastewater, etc.
  - Salt, fresh, brackish water
- Recreational – Water parks, Swimming, etc.
- Recycled water
- Reservoirs
- Rural vs. Urban use
  - City Infrastructure
- Securities: food, water resources, state, energy, community, economic, etc.
- Transport
  - Water bodies as boundaries and as connectors
  - Waterways
- Users and sectors
  - Corporate vs. national vs. regional vs. household vs. individual uses of water
- Virtual water
  - Virtual rivers
  - Food
  - Manufactured goods
  - Use in services
  - Water-rich and water-poor flows
- Wastewater return flows
- Water flows uphill to money
- Water-Energy-Food Nexus

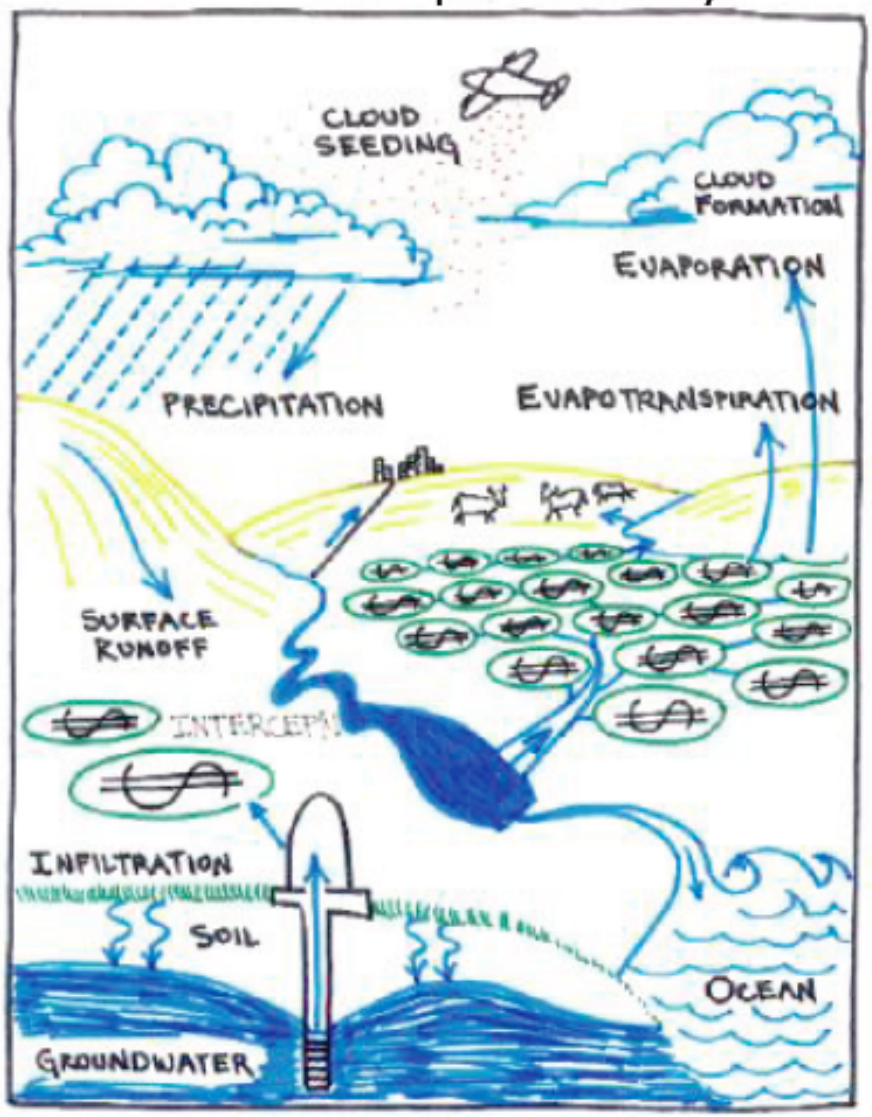
Adding (some) human use…



Accessed online at <recycledwater.com.au>.

Slowly adding economic, social, and political, and global concerns

'Water Flows Uphill to Money'

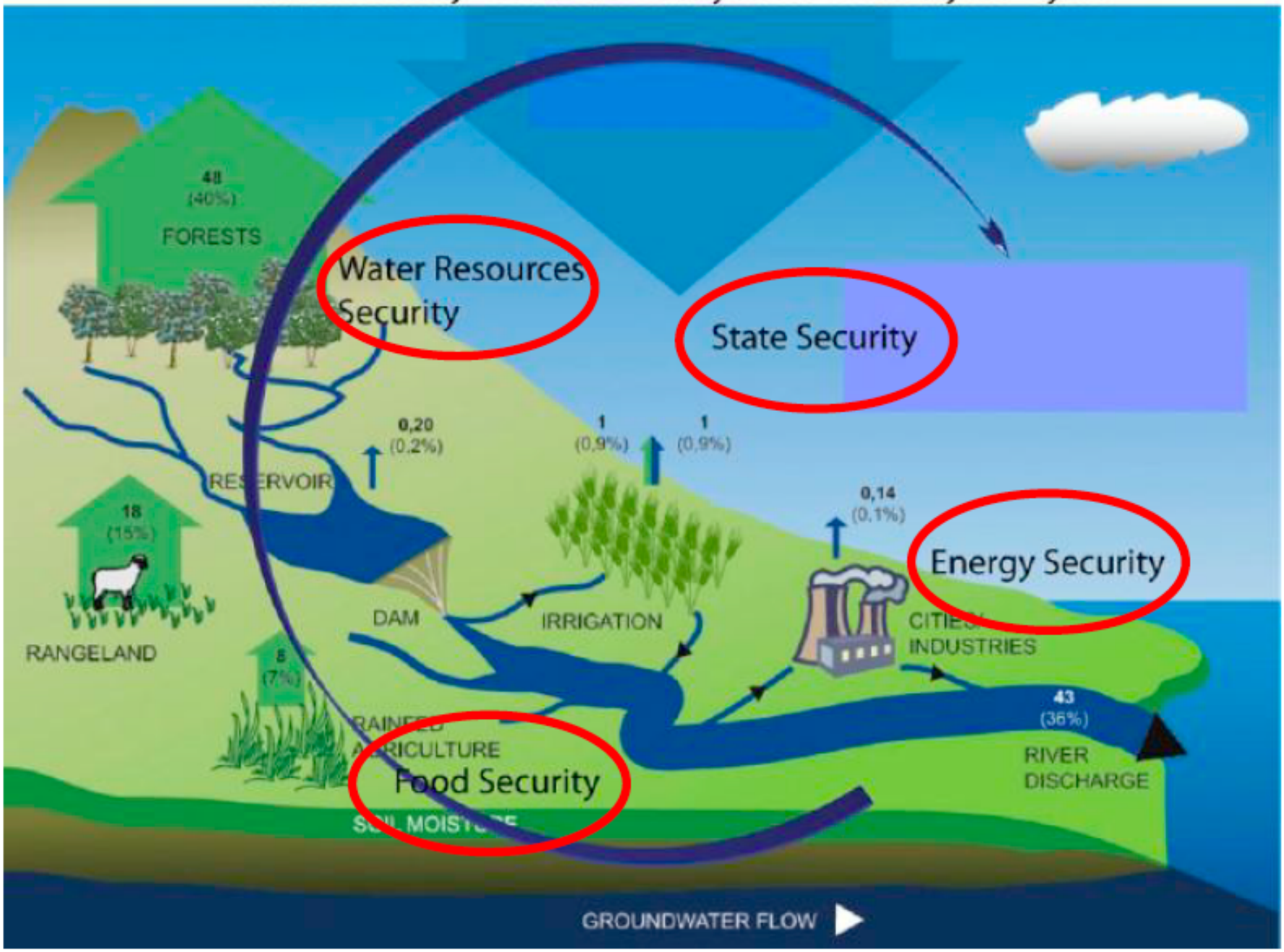


The hydrologic cycle as it occurs today.

Water flows to money.

Kate Ely, Hydrologist, Confederated Tribes of the Umatilla Indian Reservation, Oregon [via Todd Jarvis]

Water Security - related Security Areas in the Hydro-Cycle



From Mark Zeitoun

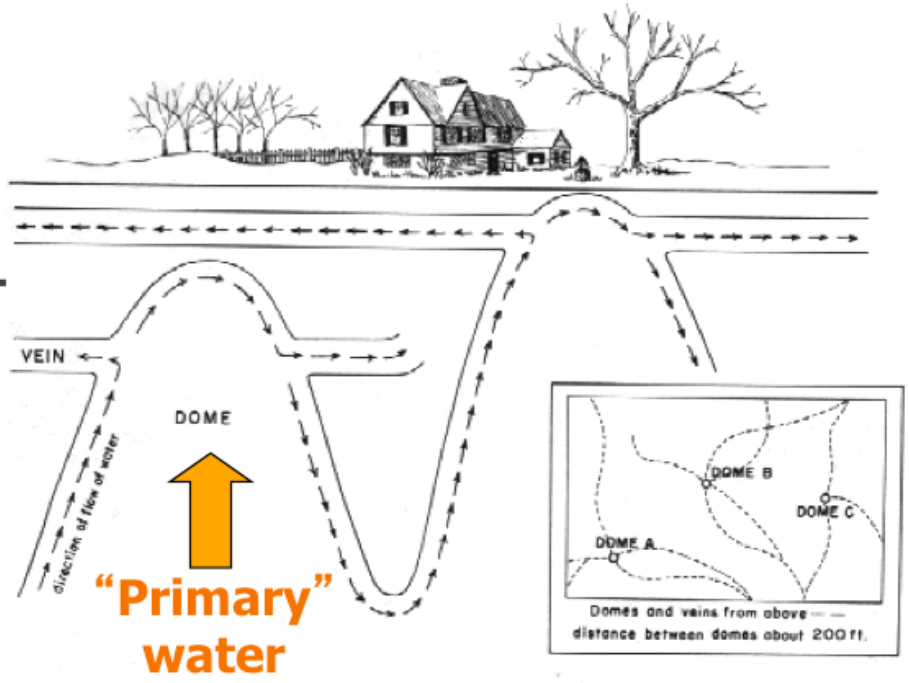


FIG. 17.—The occurrence of ground water as seen by a well-known water diviner: Underground water originates in *domes*, which are "single spouts of water rising from deep underground" and which always occur on high land, "far above the so-called water table" (Roberts, 1951). The depth of a dome beneath the surface varies. From these domes emerge *veins* of *flowing* water (as distinct from saturated earth)—from two to as many as fifty from a single dome—which spread out in all directions. The veins from a particular dome tend to be

What the American Water Witch "senses"

What the Geologist thinks

From Todd Jarvis

Post-Modern Geohydrologic Balance: It is not just about water anymore

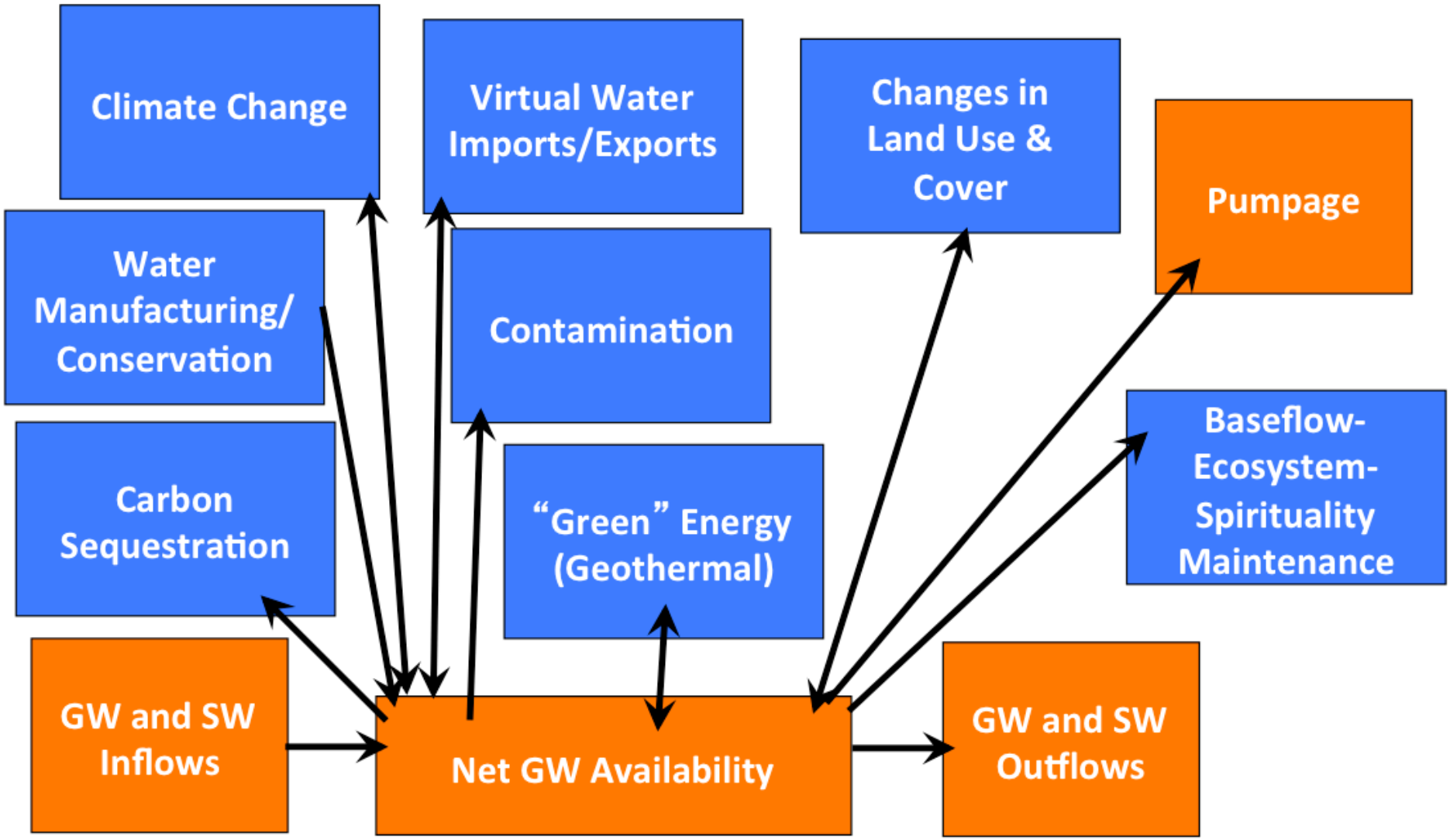
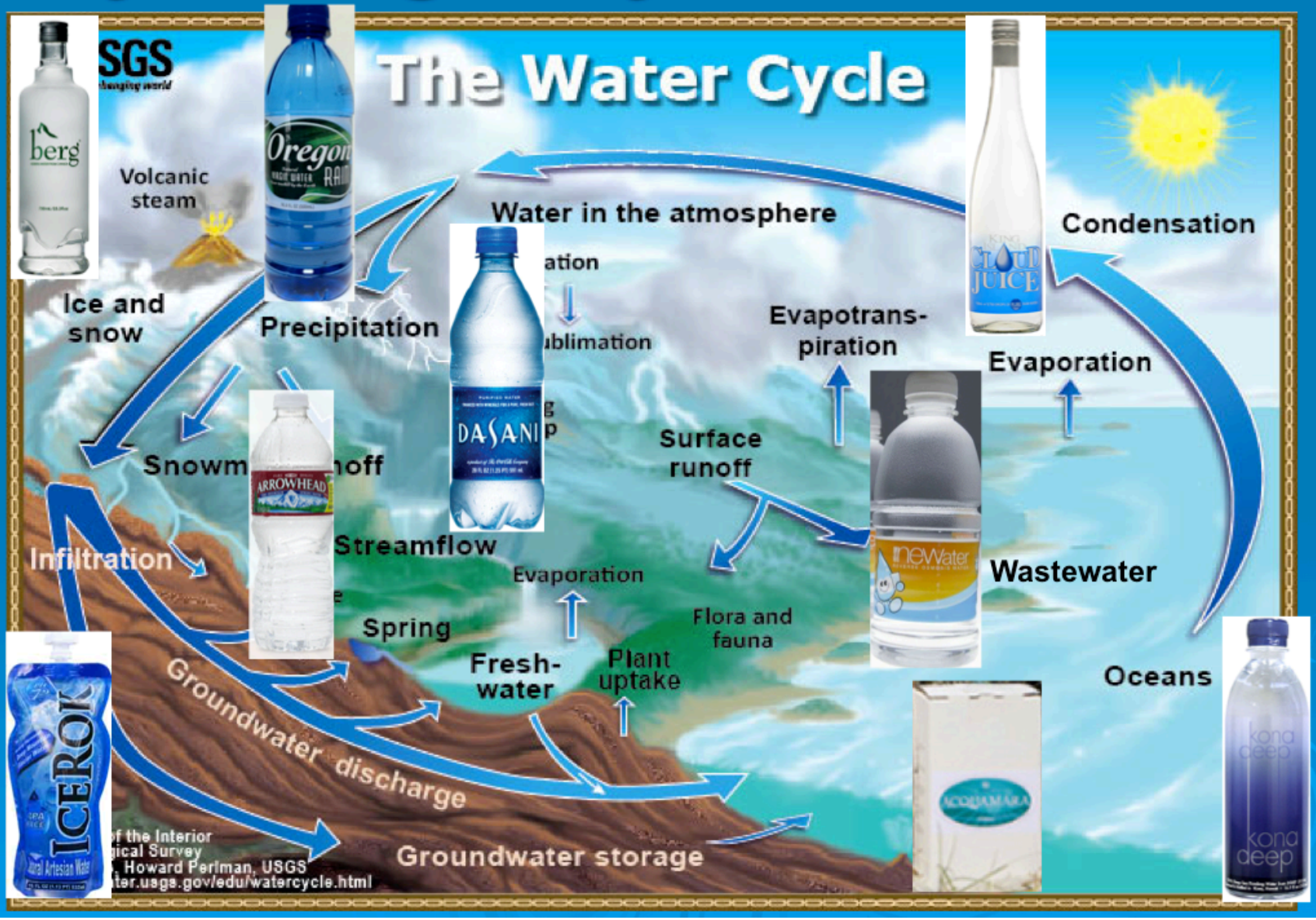


Diagram adapted and modified from Jarvis (2011)

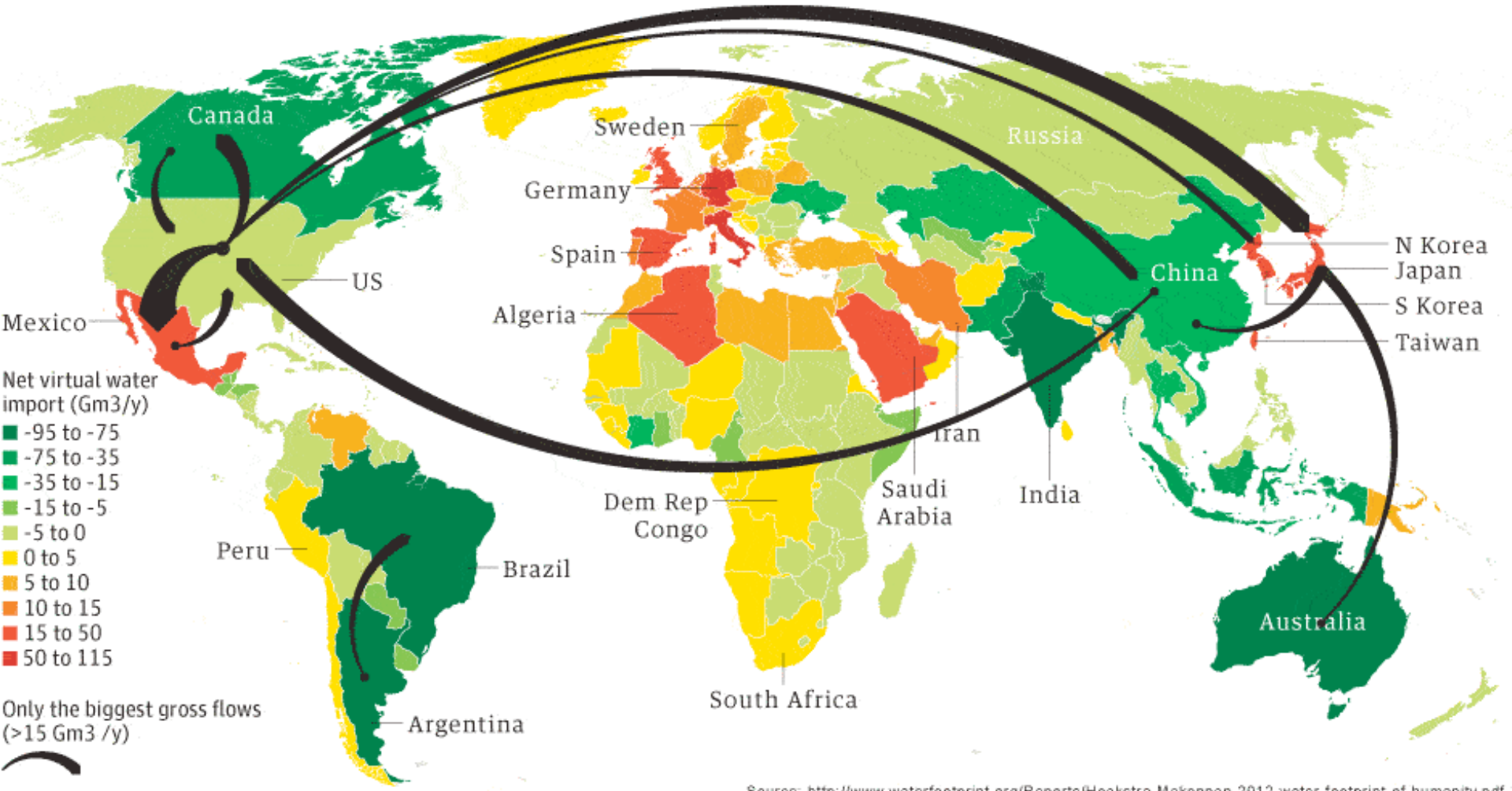
Hydrologic Cycle in Bottles



From Todd Jarvis, *Bottling Oregon's Oil: Conflict and Cooperation or Conquest in Cascade Locks, Oregon*, 2012.

Virtual water balance

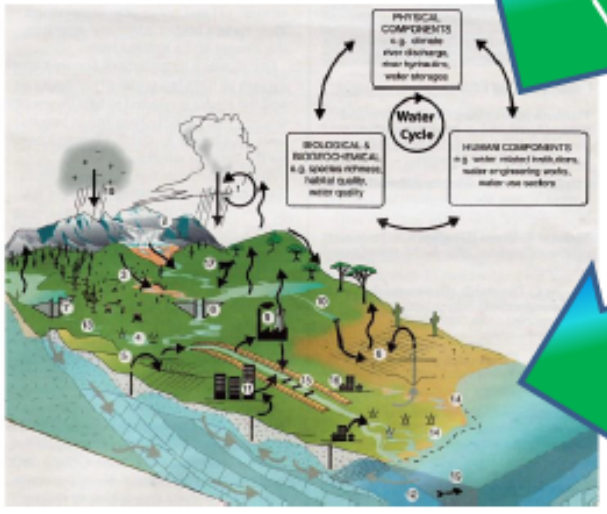
The exports and imports of water through food and commodities, 1996-2005



Source: http://www.waterfootprint.org/Reports/Hoekstra-Mekonnen-2012-water-footprint-of-humanity.pdf

guardian.co.uk

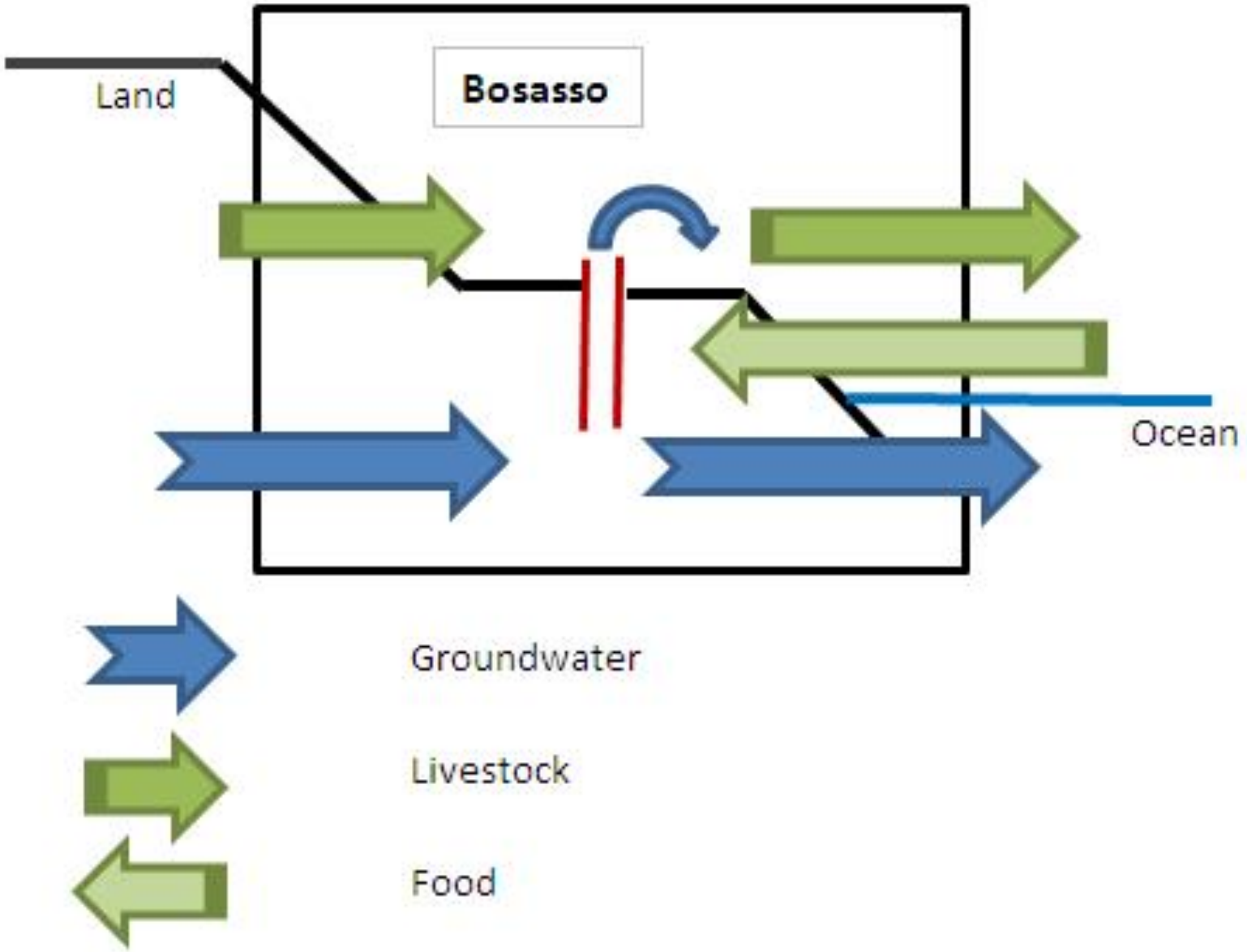
VIRTUAL WATER OUT AND IN



Virtual water out

Virtual water in

From Francesca Greco

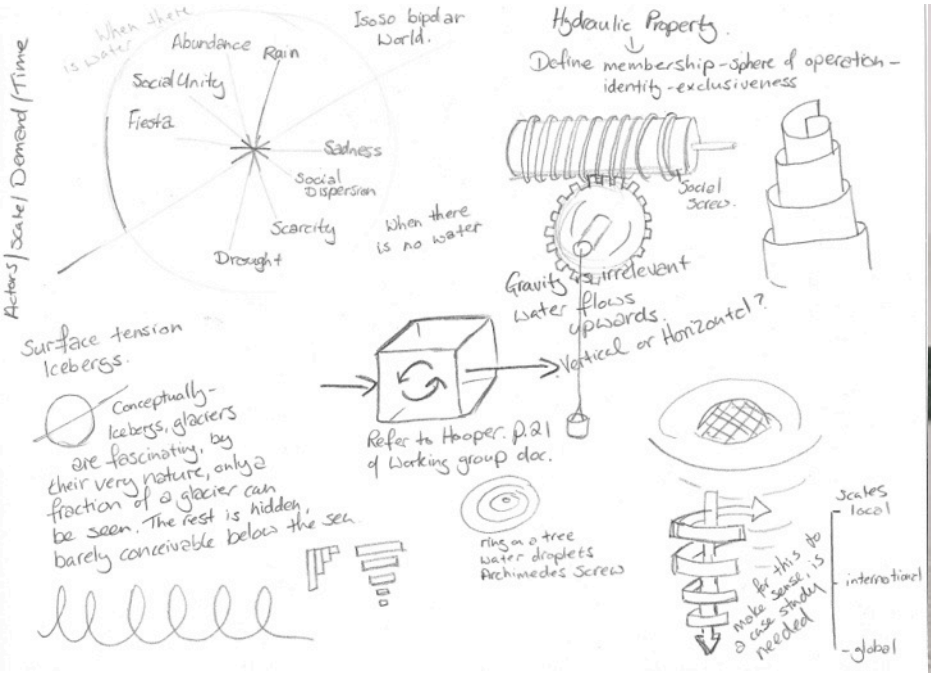


The Hydro Cycle in city of Bosasso, Puntland Somalia. Melvin Woodhouse, 2013.

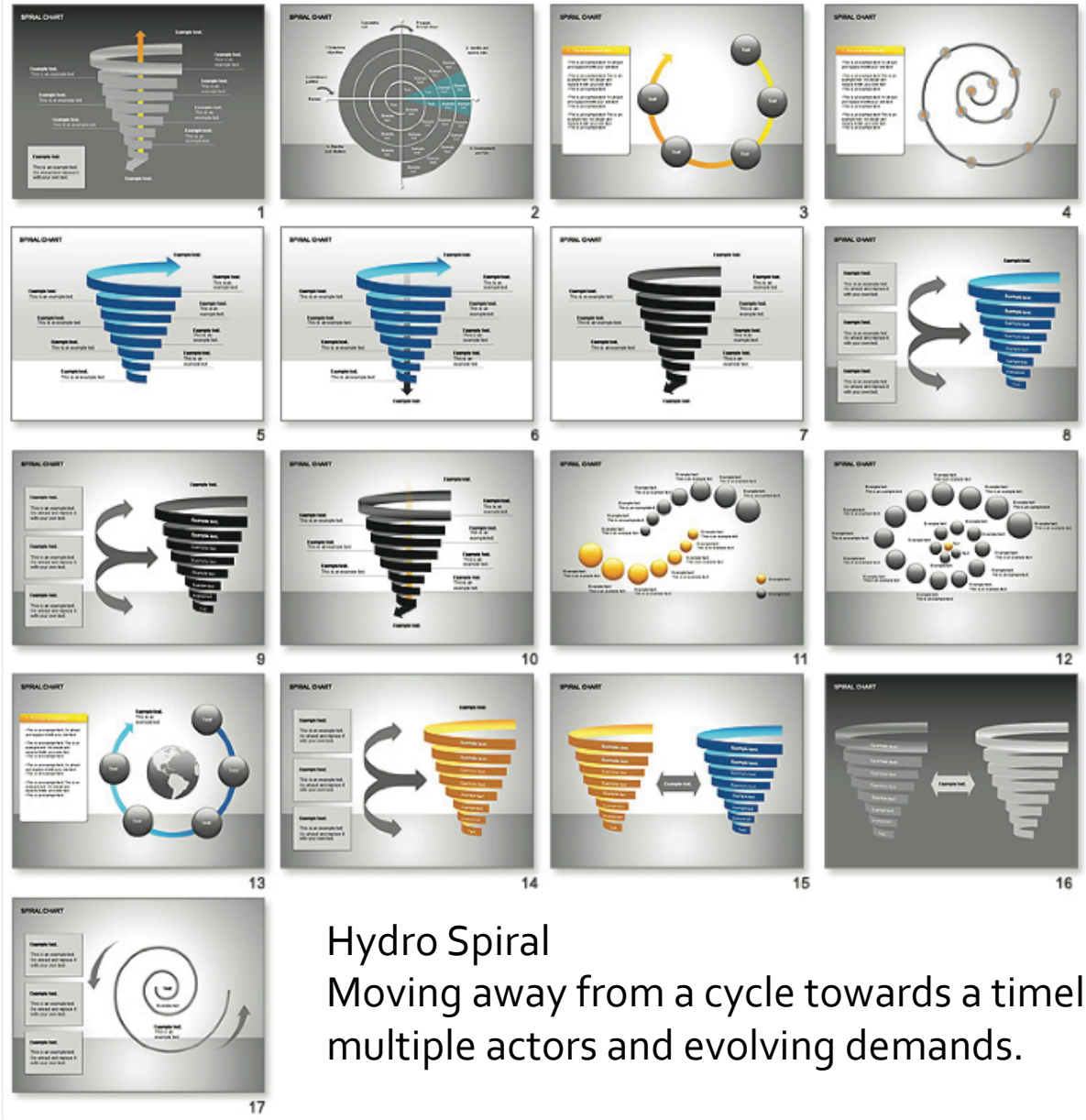
These images:

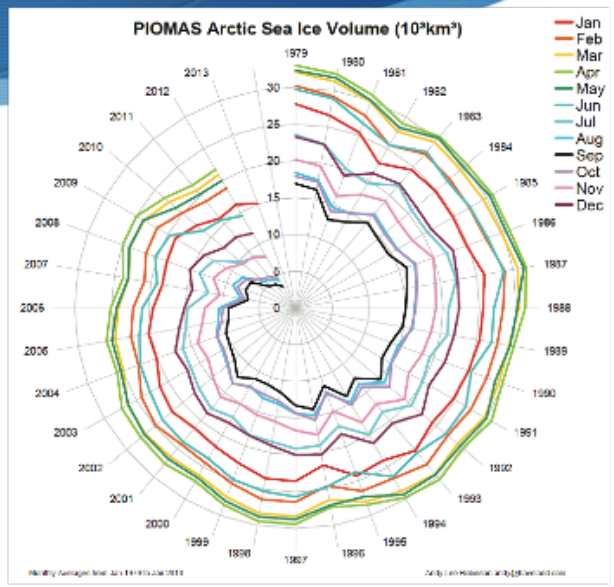
- Less prevalent
- ‘Fix’ a *single* issue

The Hydro Spiral



Spiral Jetty
Robert Smithson (1970)





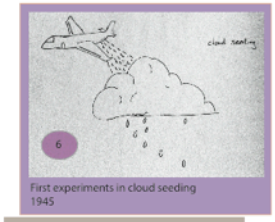
Hydro Spiral

Moving away from a cycle towards a timeline that communicates scale, multiple actors and evolving demands.

HYDRO SPIRAL

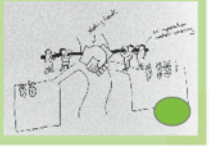
work in progress
25.06.13 - 05.07.13

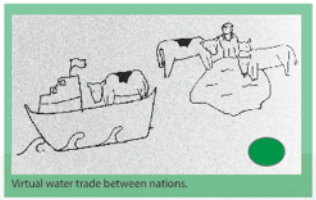
Ruth Macdougall
www.ruthmacdougall.info

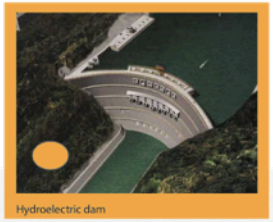


First experiments in cloud seeding
1945

water cooperation amongst riparian stakeholders



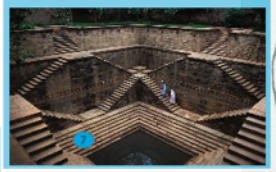

Virtual water trade between nations.


Hydroelectric dam

Protest against dam in rural areas by farmers, communities and activists

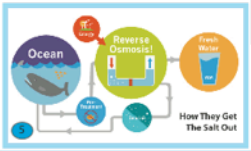

Pollution & increased energy need for desalination

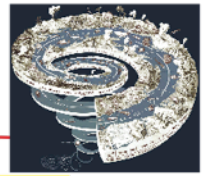
Indian step well - blue water harvesting/place of worship



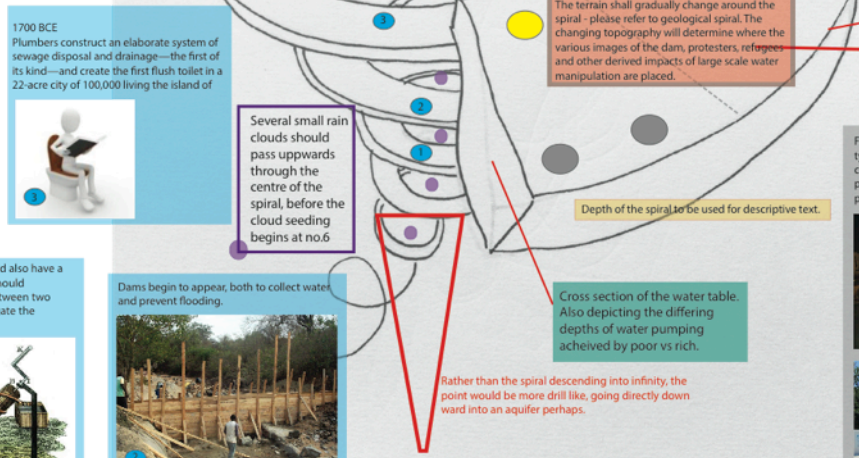

Political impasse between two countries, whose discussions on water are unworkable due to deeper political tensions - water in this case, is a mask.

A channel of blue should travel along the spiral. In the earlier stage of the spiral (eg the bottom) the channel should travel almost centrally along the path of the spiral. However, towards the top, as political power and inequity grow, the water channel should dramatically veer to the outer rim of the spiral.





Regardless of terrain, the countires on the inner circle are water poor due to lack of politicalpower and money.
Equally, the countires on the outer cirlce are water rich due to their political power and money. On the upper ring of the spiral, the amount of urban architecture should increase and the central water body at the middle of the spiral should increasingly diverge towards the outer ring.



The terrain shall gradually change around the spiral - please refer to geological spiral. The changing topography will determine where the various images of the dam, protesters, refugees and other derived impacts of large scale water manipulation are placed.

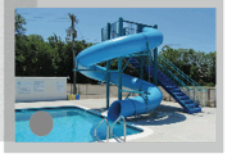
312 BCE
Roman aqueducts carry 1.2 billion liters of water a day a distance of 57 miles in order to bring fresh water to the city. Aqueducts were in use hundreds of years earlier in Persia (Iran), India, Egypt, and other Middle Eastern countries.

1700 BCE
Plumbers construct an elaborate system of sewage disposal and drainage—the first of its kind—and create the first flush toilet in a 22-acre city of 100,000 living the island of

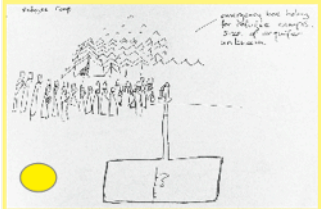
Several small rain clouds should pass uppwards through the centre of the spiral, before the cloud seeding begins at no.6

Depth of the spiral to be used for descriptive text.

Fountain in the dessert -symbol of identity, amongst a community, expressing cohesion, whilst also commenting on purity and those who are thought to pollute the community by their presence.

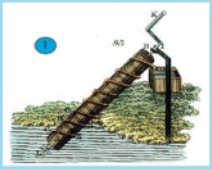


Refugee camp derived from political upset, impasse concerning water dialogue and the need for migration. Emergency bore holing occure as a result, with no time to consider the size of the aquifers and with no hope of replenishing them



The lower stages aim to introduce the key progressions water technological :
Early water harvesting for irrigation –
Archamedes screw
Dams
First flush toilet and sanitation
I have also included the Indian step well, also used for religious puja
Roman aquaducts
Aquaducts
Desalination plant
Cloud seeding

The archimedes scres should also have a man turning it, the screw should connect the water body between two levels on the spiral and irrigate the upper.

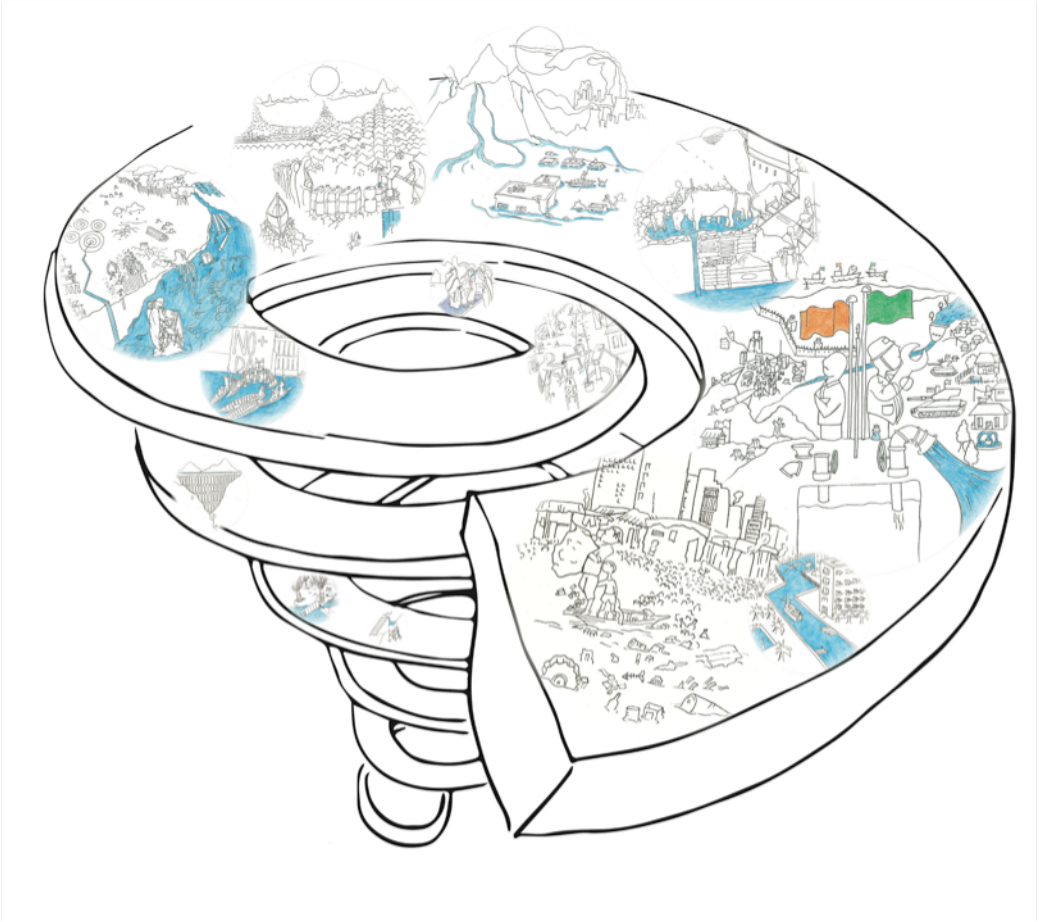


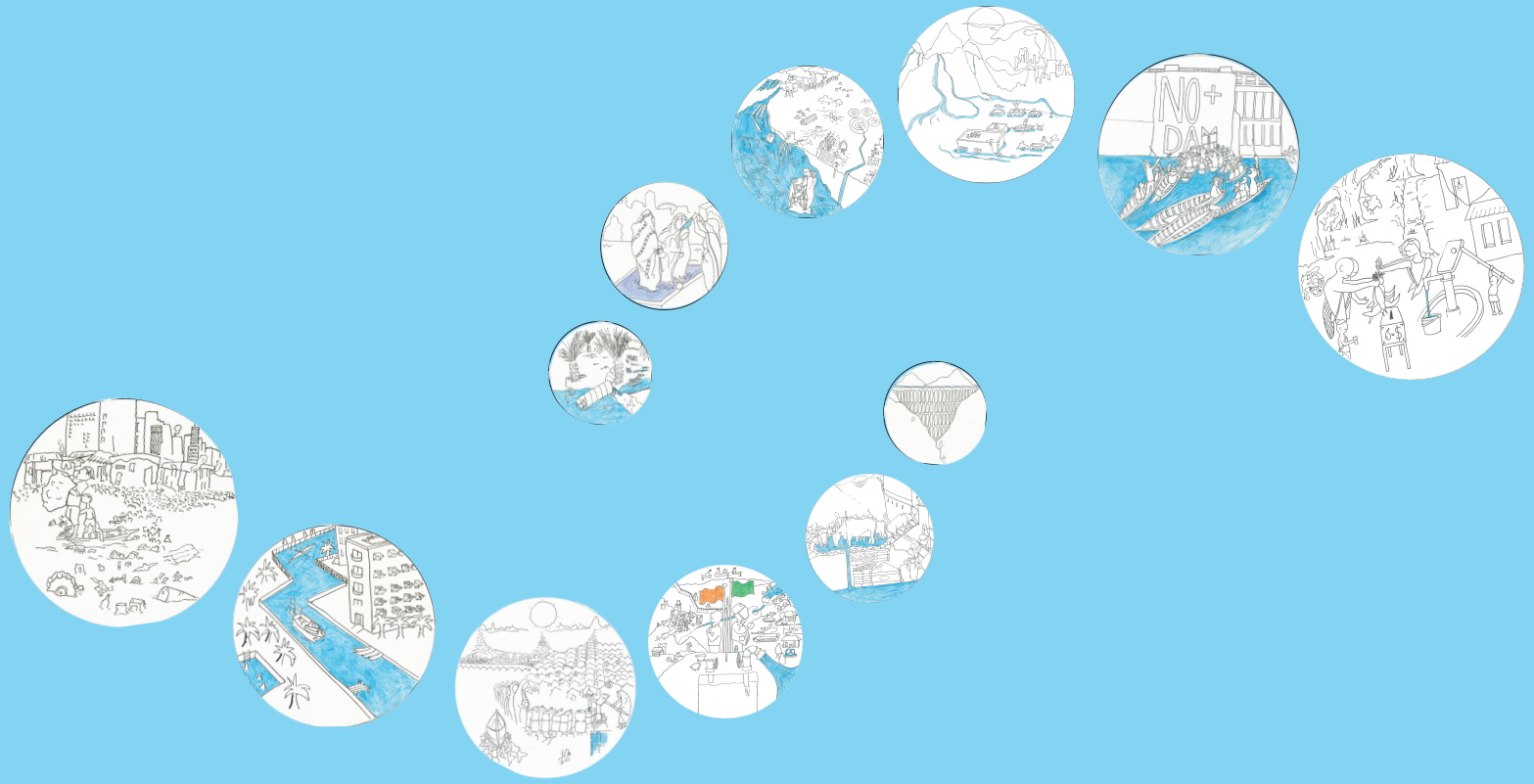
Dams begin to appear, both to collect water and prevent flooding.

Cross section of the water table. Also depicting the differing depths of water pumping acheived by poor vs rich.

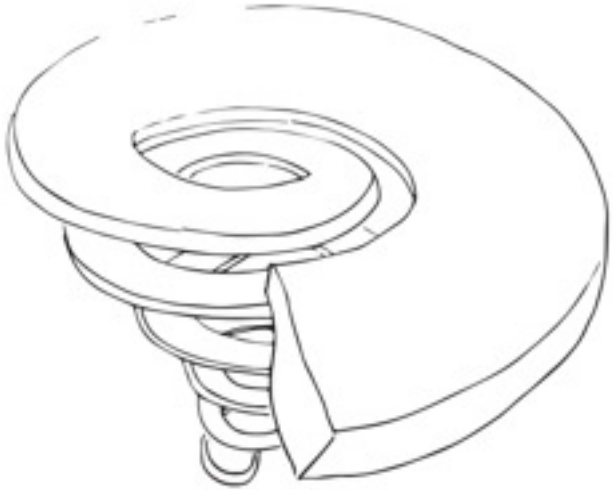
Rather than the spiral descending into infinity, the point would be more drill like, going directly down ward into an aquifer perhaps.


NO +
DAM

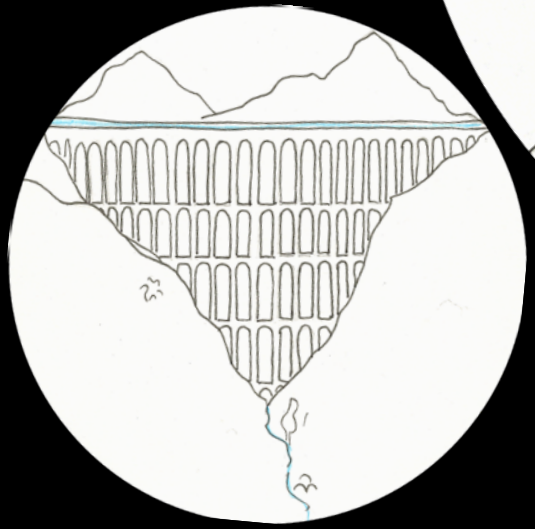


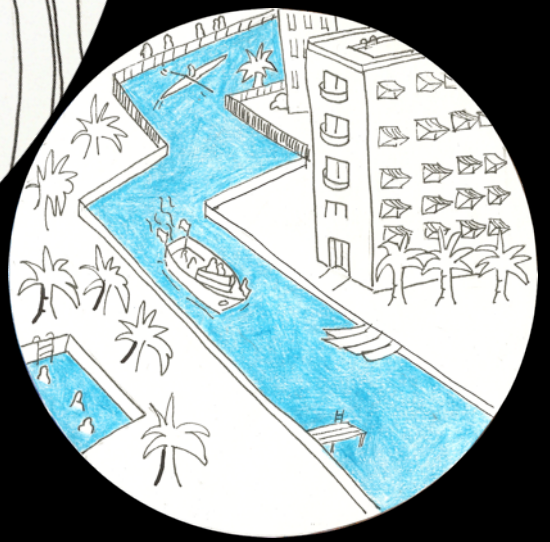


- Pre-drawn discs
- Draw-your-own discs
- Flexible positioning




NO
DAM





As a participatory tool:

- Prompts more questions than it answers
  - → catalyst for ideas rather than defining visual solution

- Most effective when applied to individual case studies rather than trying to address *everything*

As art:

- Art shows bias, allowing for accessible critiques
- Allows creativity of students/informants to come forward
- Readily permits changes, edits, expansions

As a model:

- Lends itself to animation/3D
- Not static
- The world's water is precious but our diagramme is not, so feel free to make use, undo it and challenge it, and be sure to let us know what you find

Thanks much!

Questions and comments to Becca Farnum at rebecca.farnum@kcl.ac.uk